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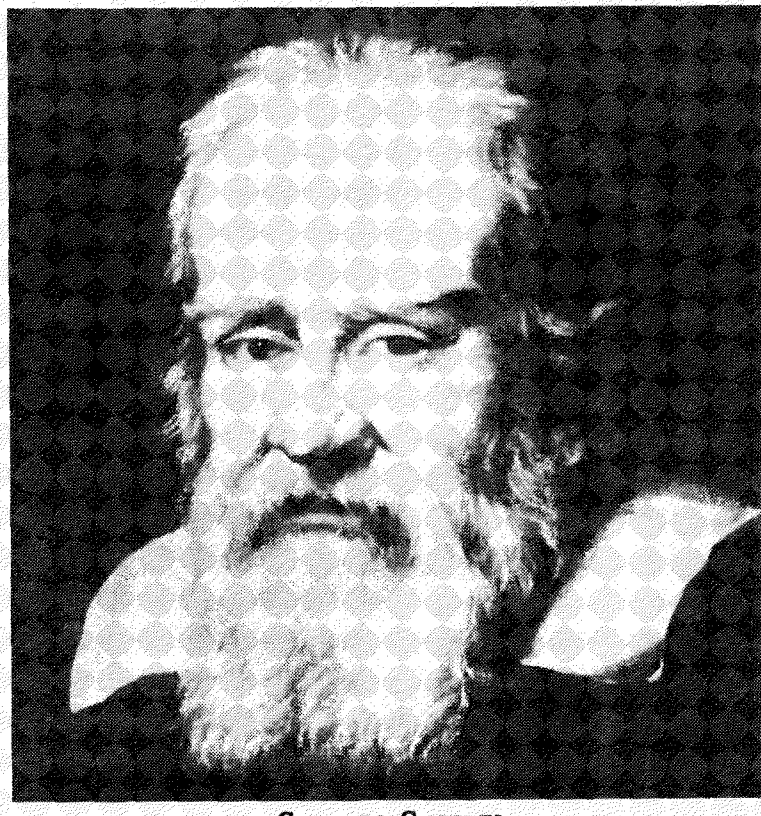

GALILEO GALILEI

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About this issue . . .

Is the creation-evolution controversy a debate between religion and science over the same territory? Many on both sides have said that it is. But others have denied this, arguing that "creation" and "evolution" are not comparable, mutually exclusive alternatives that serve the same purpose. In this light, the notion that there is a significant intellectual debate called "the creation-evolution controversy" appears to be a fiction created by "scientific" creationists to serve their purpose of promoting fundamentalist ideas in the public schools and elsewhere.

But one can never forget that some religions make their ethical doctrines dependent upon their conclusions about nature, and, thus, for them a conflict between religion and science exists. Galileo came face-to-face with this in his day and stands as a symbol of such controversies. In our time, educators have to deal with it in the courts.

In this issue, three articles explore the problem, directly and indirectly. Joseph E. Laferriere discusses religion and the "folk science" that religions develop and compares both to modern science. William H. Jeffreys analyzes a particular Bible-based historical chronology, demonstrating that religions are also capable of producing a "folk history" that is equally out of step with modern scholarship. And Ronnie J. Hastings brings us up to date on the ongoing saga of creationists who seek, even after their recent retractions, to demonstrate that both the Bible and the Glen Rose limestone provide evidence of recent human and dinosaur coexistence.

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Cover: Subterman's portrait of Galileo Galilei, painted about 1640, now in the Galleria de' Pitti at Florence

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Morality, Religious Symbolism, and the Creationist Movement

Joseph E. Laferrière

> And today, this God-rejecting, man-exalting philosophy of evolution spills its evil progeny—materialism, modernism, humanism, socialism, Fascism, communism, and, ultimately, Satanism—in terrifying profusion all over the world. [Morris, 1963:83]

Many people view controversies such as the present debate between creationists and evolutionists as conflicts between religion and science. The idea of an inevitable discord between the two has been around for some time and is held by many in scientific circles. This conception is exemplified by the classic, two-volume work *A History of the Warfare of Science with Theology in Christendom* (White, 1896). This is still considered by many as a classic authority on the subject, but the book's extreme viewpoint has been criticized as simplistic by several scholars (Lindberg, 1983). The overall thesis is based upon a fundamental misunderstanding of the nature of religion by both scientists and theologians and, certainly, by the lay public as well. The way these two terms are properly defined, science and religion appear to be entirely separate realms of human behavior with no potential for conflict. Understanding the nature of these perceived disagreements and the reasons why the supporters of pseudoscientific theories are so fervent in their beliefs requires a knowledge of the structure of religious systems and the symbolic nature of many aspects of religious beliefs.

The Structure of Religions

Whereas science is considered to be the systematic study of the natural universe,

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religion is a social phenomenon best defined as a system of morality and ethics which establishes a common basis for human decision-making and which provides emotional support and a sense of purpose and direction for its adherents. Such a broad definition includes not only the traditional Western religions but also smaller-scale tribal religions and nontheistic religions or "ideologies" such as Humanism, Confucianism, Hinayana Buddhism, and Marxism, which exhibit many of the same characteristics as more familiar belief systems. The idea that religion necessarily involves belief in God is a common American misperception based upon most people's limited experience with other systems.

French sociologist Émile Durkheim (1915) suggested that one characteristic shared by all religions is that they make a sharp distinction between the sacred and the mundane. The mundane includes all the everyday aspects of life, such as the ethics used in decision-making, the emotional and psychological benefits from religious devotion, and so forth. The sacred consists of some special symbol or idea which serves to lend authority to the mundane aspects of the religion, changing it from a haphazard collection of rules and rituals into a relatively coherent system of belief. Frequently, the adherents to a particular belief system portray the ultimate purpose of the religion as wound up in the sacred symbol itself (for example, worship of God) rather than acknowledge the mundane side of the religion as primary. This is because the symbol must be thought of as being real or it loses its meaning.

This sacred concept may take many forms. Frequently, it is represented by the belief in one or more supernatural beings, but other concepts may serve the same purpose. A person may serve as the sacred symbol, such as a king or an ancestor, as may an object or a totemic animal. Even a pure idea may be held sacred, as are the four central truths of Buddhism, the Revolution in Marxism, or the ideals of intellectual freedom and the dignity of the individual in contemporary Unitarian-Universalism (Robinson, 1985).

Harold Fallding suggests three criteria by which one may determine what is sacred about any particular religion: (1) it must be transcendent, something above and beyond the realm of ordinary experience; (2) it must be comprehensive, something so all-inclusive and compelling that all other aspects of the religion may ultimately be traced back to it; and (3) it must be something dogmatically agreed upon by all members of the group (Fallding, 1972). People may disagree about details (for example, about the proper way to perform a certain ritual), but they must be in agreement about the criteria by which they are to decide the argument—that is, in terms of the sacred principle. The colloquial expression, "Is nothing sacred?" in the sense of "Is nothing beyond question?" illustrates this point quite well.

Mythology plays an important role in religion. Many people think of myths as being quaint folk tales which are obviously false to the nonbeliever but which some naive, unenlightened people tend to take seriously. There is, however, a sharp distinction between folk stories, which are told for enjoyment, education, or

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other mundane purposes, and sacred myths, which are held to have special significance and special authority. Myths serve to define the properties of the sacred concept and to elaborate on the proper relationship between the sacred and the mundane. For example, a myth stating that the first woman was created from a certain unimportant portion of the male anatomy for the purpose of providing companionship for the man may be interpreted as stating that women's role is less important than that of the man in the society that places credence in that particular myth. Innumerable generations of chauvinistic males have used just such a myth to justify social roles existing in their societies.

Mythology, in turn, is often supported by what anthropologists call *folk science*, a collection of pseudoscientific beliefs about how nature operates. The relationship between mythology and folk science is very intimate and works in both directions. Mythology provides the central paradigms for folk scientific theories, and folk science serves, at least in the minds of the practitioners of the religion, to reinforce and lend credence to the mythology. Folk science differs from true science in that it is not subject to rigorous testing and independent verification and it is frequently vitalistic, making recourse to unseen and unmeasurable forces and entities. In this way, it can interact directly with the sacred concept, especially if it is a supernatural symbol, since much of nature is often conceived of as interacting with the supernatural world.

We can therefore picture a hierarchy of roles which religion plays, as shown in Figure 1:

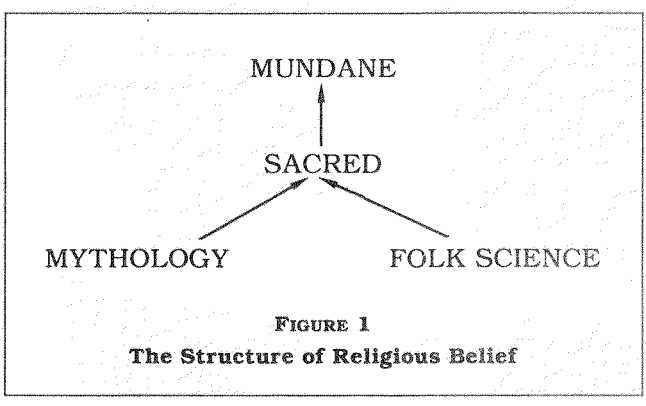

Figure 1
The Structure of Religious Belief

The primary function of religion is concerned with ethics and psychology at the mundane level. This is supported by the people's concept of the sacred, which in turn is given form and credence by mythology and folk science. People often rely upon folk science so heavily for verification of the structure of their belief system that they interpret challenge to folk scientific theories as threats to the entire

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structure of their religions, even though the challenge to the core of the belief system is very indirect indeed. This can lead to denial of facts which contradict the established perceptions in an attempt to remove the sources of psychological conflict involved in evaluating facts and revising one's world view and one's bases for decision-making. Herein lies the crux of the perceived conflict between science and religion.

The Trobriand Islanders

One example of such a conflict in a non-Christian society involves the inhabitants of the Trobriand Islands in the South Pacific off the coast of New Guinea (Malinowski, 1948). At the time they first encountered Western anthropologists, the Trobrianders did not believe that there was any connection between sexual intercourse and pregnancy. This was not a case of sheer ignorance. The people had domesticated animals and were perfectly cognizant of the necessity of males for the propagation of the herd, but they refused to extrapolate the idea to humans. When visitors tried to convince the people of the white man's theory, the visitors encountered active resistance and even ridicule.

A little knowledge of the Trobrianders' religion offers an explanation for the resistance to these new ideas. They believed that various types of spirits inhabited the forest, interacting with living humans on a regular basis. These spirits caused and cured diseases, affected human interactions, and so forth. The people had rituals honoring these spirits, and their entire magical system (magic being applied folk science) revolved around the invocation of the powers of these spirits. The people also believed in reincarnation. They believed that one of the spirits of the dead would enter a woman's body and transform itself into a child. The anthropologists, by challenging this folk scientific theory of procreation, were calling into question the Trobrianders' belief in these spirits and threatening the integrity of their religious beliefs.

Lysenkoism

Another example involves the modern secular religion of Marxism. Creationists are fond of pointing out that Marx made several favorable comments about Darwin and his theory of evolution, even to the point of having considered dedicating *Das Kapital* to the famous naturalist. In this way, the creationists feel they can capitalize upon Marx's unpopularity in the West and make Darwin take the blame for the spread of communism. However, there is much more to this story which they blissfully ignore.

It is true that Marx and Engels spoke favorably of the theory of evolution,

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but they strenuously opposed Darwin's proposed evolutionary mechanism, natural selection. In this they were in basic agreement with many of their nineteenth-century contemporaries who could not picture a hereditary mechanism for natural selection. Marx and Engels rejected the theory for somewhat similar reasons as those given by present-day creationists. Marxist theory is firmly rooted in the much older philosophy of materialism: the belief that the universe consists solely of matter and energy and its resultant properties. Materialists believe that nature operates according to certain definite rules which are constant throughout the universe. This viewpoint thus precludes the roles which supernatural forces might be conceived as playing. Natural selection involves a large element of chance, which is as inimicable to Marxist determinism as it is to fundamentalist notions of divine creation (Zirkle, 1959; Graham, 1972). Marx and Engels preferred Lamarckian concepts of the inheritance of acquired traits, since the orthogenetic aspects held more philosophical appeal (Zirkle, 1959:6). They condemned natural selection as a product of "reactionary" Malthusian ideas.

To quote from Lysenko's infamous speech announcing the imposition of his theories on Stalinist Russia (1948:59–60):

> We must not wait for favors (i.e. lucky chances—T.L.) from nature; our task is to wrest them from her. . . . By ridding our science of Mendelism-Morganism-Weismannism [that is, genetics] we expell fortuities out of biological science. We must firmly remember that science is the enemy of chance.

Marxists also believed that human beings are all formed alike and can be molded into any form desired. Soviet scientists espousing theories emphasizing differences between groups of organisms, especially people, were frequently branded as supportive of Nazi-style racism. Differential reproduction, of course, is the core of the theory of natural selection. Eventually, any study of human genetics, even from a medical perspective, was suspect (Joravsky, 1970).

Quantum mechanics was also frowned upon by Soviet theoreticians for similar reasons, since its emphasis on the role of the observer seemed to imply philosophical idealism, while the role of chance in predicting the path of an object called into question the role of causality in nature and the certainty of natural laws (Graham, 1972). Other scientific theories, such as modern views of cosmology, were condemned because they lent themselves to arguments in favor of divine intervention (Graham, 1972).

While Lamarckian ideas died in the West as a result of lack of experimental verification, they survived in the Soviet Union because of support from Marxist theoreticians and the intervention of Stalinist political authorities. Those supporting these theories emphasized a contrived dualism between "bourgeois science" and "proletarian science" remarkably similar to the creationist "two model"

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approach.

By 1948, these Lamarckian (or, more accurately, degenerate pseudo-Lamarckian) theories had won official approval and were installed as the only acceptable bases for biological research in the Soviet Union. The charlatan Lysenko was made dictator of biological sciences throughout the Soviet Union, where he remained more or less in control until the fall of Krushchev in 1964 (Medvedev, 1969). Soviet agriculture was thus set back several decades as plant and animal breeders struggled with totally ineffective methods.

Ben Franklin's Lightning Rod

Medieval Europe had a rather elaborate folk science based largely upon the literal interpretation of the Bible. This folk science also received contributions from the theories of the ancient Greek philosophers and from the pre-Christian religions from other parts of Europe. The emerging science of the seventeenth and eighteenth centuries had to counteract many of these long-standing notions in order to gain acceptance and counter the political power of the established churches, which had used these beliefs in their moralizing messages for years and held them to be inviolate.

Benjamin Franklin, for example, encountered the wrath of both Catholic and Protestant theologians over his invention of the lightning rod (White, 1896). Pre-Christian peoples in most of Europe believed that lightning was caused by one of their gods—Thor in northern Europe and Jupiter in the south. In accordance with the biblical admonition that "the gods of the heathens are devils" (Psalms 96:5), the power of causing lightning was transferred to Satan when the people were Christianized. One of Lucifer's many medieval nicknames was "The Prince of the Power of the Air." Throughout the Middle Ages, churchbells across Europe were baptized and then rung during thunderstorms to scare away Satan.

In 1752, however, during the heyday of the New England "fire and brimstone" epoch, a Bostonian deist named Franklin invented the lightning rod and was promptly denounced from pulpits on both sides of the Atlantic for challenging the power of the devil. Since his contemporaries believed that Satan cannot do anything without the acquiescence of the Almighty, this implied to them that Franklin was thwarting the will of God. Franklin had thus challenged both the people's conceptions of their deity and the folk science which supported it. For twenty to thirty years, churches in both Europe and America refused to allow lightning rods to be affixed to their steeples, with some tragic results.

Galileo

Perhaps the most famous and long-lasting controversy involving a perceived clash

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between science and religion is the case of the heliocentric theory of the solar system (White, 1896; Kuhn, 1959; Gingerich, 1982). The idea that Earth moves around the sun is an old one, dating back to Pythagoras in the sixth century BCE, but the idea failed to gain much support and remained an academic curiosity until resurrected by Nikolai Kopernicki (Copernicus) in the sixteenth century. Copernicus arrived at his theory about 1500, while a professor in Rome, but was so fearful of the authorities that he refrained from publishing his ideas until 1543, when he had retired to his native Poland and was on his death bed. His editor insisted on adding a disclaimer to the front of the book, stating that the theory was being presented not as fact but merely as a thought experiment, a common practice among wary scientists of that era. The statement served its purpose well, preventing the book from being banned outright, although it did draw scathing denunciations from both Martin Luther and John Calvin. Copernicus was accused of attempting to resurrect ancient pagan beliefs, which is particularly ironic since the ancient philosophers who first proposed the idea had been vehemently denounced as heretics by the Greek community.

Some seventy years later, however, Galileo Galilei reached much the same conclusions as Copernicus and obtained further evidence through his telescope to support the idea. He made the mistake, however, of asserting that the theory was in fact true and thus incurred the full furor of the church. Both the Catholic church and the various Protestant denominations at the time were highly sensitized and defensive of their positions due to their mutual conflict over the Reformation, in much the same way that the Cold War polarized Soviet opinion in the late 1940s (Kuhn, 1959; Graham, 1972). Galileo was twice called before the Inquisition and forced to recant his beliefs. The second time, in 1633, all of his and all of Copernicus's books were placed on the church's "Index of Proscribed Books," where they remained until 1835. A flood of books were printed and sermons preached by both Catholic and Protestant theologians denouncing Galileo as an atheist who thought to dethrone God and discredit the entire Bible. Galileo was not an atheist but remained a loyal Catholic to the bitter end, making every attempt to find scriptural support for his theory.

The tirade against the heliocentric theory did not subside quickly. Even as late as the 1870s, books were still being published denouncing Galileo's theory. It was not until 1984, some 440 years after Copernicus first proposed the theory to modern science, that Pope John Paul II took steps toward acknowledging that the church had erred in condemning Galileo (Golden, 1984). Pro-geocentric groups continue to advocate their position to this day; one of these groups has even been reported as proposing a space-shuttle experiment to "prove" its theory (Kendig, 1986).

Comparing this controversy to the briefer episode over Franklin's lightning rod, we find a marked difference in the magnitude and duration of the conflict. The lightning rod polemic died out and was virtually forgotten after only thirty

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years, while the astronomical diatribes attracted more attention and persisted for centuries. Franklin was merely questioning one small piece of Christian folk science, making God just a bit less powerful and a bit less fearsome than he had been. The lightning rod proved of immense practical value, as eventually became obvious to all. Galileo, however, was challenging one of the central cornerstones of Christian philosophy: the idea that God created the universe for the express benefit of the human race, indicative of the special relationship between humans and God (Becker, 1985). Moving Earth from the center of the cosmos and making it just one more body in the heavens shakes the idea and makes it sound a little less plausible. It thus makes the human species seem less important and God's purpose in creating the universe less clear.

The Flat Earth Society

One can take this idea of the human race being at the center of the universe a step further. If the world were flat and the sun were thirty-two miles across and three thousand miles above Earth, the world would not only be the center of the universe but would also constitute most of the universe and be unique in the cosmos. The view just put forward is that held by a religious group called the Flat Earth Research Society International of Covenant People's Church Genesis 9:16 (P.O. Box 2533, Lancaster, CA 93539). The following excerpt from an editorial in the society's publication, *Flat Earth News* (Johnson, 1983), illustrates the seriousness with which its members view their mission:

> I hope all of you understand this is by FAR the most important work on earth. . . . Nothing even to compare with. No hope in Church or University or anywhere to be given a HINT of the "way things really is." Long ago a flat earther named Paul, said about the "herd" the "people" . . . if and when they REFUSE to keep a heart and mind, trying to find God—Truth, turn lose of faith, hope, and charity, THEN their minds become dark and devoid of an understanding, will believe any lie, as they tell and hear lies. So it is today, only through our society can a person become SANE and thereby regain . . . the knowledge that we are here to seek the truth and to try to ease the pain of God's creation. It is impossible to do anything if a person is INSANE. All who believe the world is a ball are INSANE! Science RELIGION is "programmed insanity" the "Big Lie Religion," taught and invented by the Judo-Christian Religion. (Christian Science religion was founded by Martin Luther, a former Catholic Priest). Anyway the world is now "ended"—those who before December 31, 1981, believed and had faith in the Big Lie Christian

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> Science world of make believe fable, will go on, will remain a part of the "herd" . . . no one cares, no one will try to "convince" him of anything. Those who did NOT believe or do not go along with the big lie, after they heard of Flat Earth Society, will join us, as they "belong," not because they are "talked into it or are convinced" by us. No, only those who ALREADY are aware of the idiocy of the ball-globe world, can or WILL understand. All else have and will keep the "mark of the beast" which is NOT to be SANE and reasonable. [*sic*; emphasis, punctuation, and elipses in original]

This passage, of course, makes even the most rabid creationist writings appear tame, but several important points may be made from it. It is difficult to determine a great deal about the belief system of the writer from this, since the author makes self-contradictory statements, first invoking the support of God and St. Paul and then denouncing the "Judo-Christian Religion." It does appear, however, that the Durkheimian sacred symbol of his religion is not God but rather the flat earth theory itself. This idea satisfies all three of Fallding's criteria for identifying the sacred symbol. The author obviously considers his work to be crucial, transcending in importance his mundane, everyday experience. This apparently motivates him to spend a great deal of time and energy and to risk the scorn and ridicule of others to further his ideals. The idea can be viewed as comprehensive, since he equates it with sanity and logic, as well as with salvation. He is extremely dogmatic and emphatic about his beliefs and considers opposing viewpoints as not only wrong and influenced by evil forces but actually insane. Science is viewed as a competing dogmatic religion.

Scientific Creationism

Much of this is relevant to our discussion of the creationism phenomenon, which is currently the most hotly debated controversy of this kind. I do feel, however, that the reasons for the devoted adherence to this particular theory are more complex and more inclusive. Evolution, by regarding the human race as a species of primate rather than as the primary purpose of the universe, diminishes the importance and uniqueness of the race in the same way as the heliocentric theory of the solar system, but there is more to the problem than that. Creationists view evolution as an attack on their religious beliefs at all levels—not only contradicting their biblical mythology and the folk science arising from the literal interpretation thereof but also shaking their perceptions of God. It also challenges the fundamentalist view of human nature and hence the moral and ethical essence of their religion (Becker, 1985).

I maintain that the sacred symbol of the fundamentalist religion is not God

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but the Bible itself, which has been elevated from mythology to the central focus of the belief system. Fundamentalists have become bibliolaters (Bible worshippers), elevating the Scripture itself to the rank of sacred symbol. They have identified the Bible and its creationist mythology so closely with belief in God that the two have become virtually indistinguishable. Literal interpretation has become the principle *raison d'etre* of the movement (Carnell, 1984). Hence the ubiquitous reference in fundamentalist literature to "Bible-believing Christians." The folk science that Henry Morris and his fellow active creationists have formulated is a mixture of biblical literalism and fundamentalist moral viewpoints with whatever pieces of modern science they can find which do not contradict their preconceived conclusions. They have thus painted themselves into a corner by committing themselves to a demonstrably false doctrine.

Contrary to popular belief, the extraordinary emphasis placed upon creation and the literal interpretation of the Bible is hardly well engrained in the Christian tradition nor the viewpoint of the majority of present-day American Christians (Hargrove, 1986). Roman Catholicism has long maintained that the pope and the church have equal authority with the Scriptures, while Luther and Calvin emphasized the dynamic relation between faith and grace rather than metaphysical aspects of the Christian heritage (Denbeaux, 1984). Many theologians throughout the history of Christianity have argued for allegorical interpretations of certain passages, especially Genesis. The fundamentalist movement is a relatively recent phenomenon in the history of Christianity, having first gained force in the late nineteenth and early twentieth centuries. It arose as a reaction to the modernist movements of that era, which attempted to reconcile Darwinism with Christian theology. It gained momentum from the liberal reaction to Social Darwinism following World War I, which caused several politically progressive activists, such as William Jennings Bryan, to join its ranks (Larson, 1985).

The Scriptures satisfy Fallding's criteria for the fundamentalist sacred symbol. The Bible is viewed as divinely inspired if not authored directly by the Almighty himself. Its role is certainly comprehensive, since fundamentalists rely upon it for answers to all sorts of questions—mundane as well as theological—and invoke it to support political positions on abortion, homosexuality, and so forth. And there is no question about their unswerving dogmatism concerning its literal interpretation (Sturm, 1982; Doland, 1983). Henry Morris, acknowledged leader of the creationist movement, in discussing discrepancies between the Bible and modern science, states:

> It is precisely because Biblical revelation is absolutely authoritative and perspicuous that the scientific facts, rightly interpreted, will give the same testimony as Scripture. There is not the slightest possibility that the *facts* of science can contradict the Bible and, therefore, there is no need to fear that a truly scientific comparison of any aspect of

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> the two models of origins can ever yield a verdict in favor of evolution.
> [H. Morris, 1974a:15]

Keister adds: "Whenever theory and Scripture truly disagree, the theory obviously must be modified" (1974a:15). Morris (1984) attributes the very strength of the Creation Research Society to its specific doctrinal commitment and to edict in its constitution prohibiting compromising of its rigid fundamentalist position.

Creationists naturally prefer to find evidence from scientific studies which supports rather than refutes their folk science. Much of their literature, exclusive of their misguided criticisms of legitimate scientific theories, consists of attempts to use scientific findings to reinforce their previously held ideas. Bouw (1980), for example, attempts to identify the Star of Bethlehem from astronomical data. Koontz (1971) cites modern chromosomal studies in support of the contention that women were indeed created from male tissue, since creating an *XX* genome from an *XY* would be easier than the reverse; he adds that the choice of a rib as the anatomical portion of Adam's body from which Eve was made was particularly appropriate, since bone marrow has been found to be one of the best sources of cells for tissue culture. Other writers use archeological evidence to "prove" the authenticity of biblical accounts (for example, Balsiger and Sellier, 1976). Brauer (1971) cites the complexity of the realm of organic chemistry as evidence for the infinite wisdom of the Almighty. This is a recurring theme in creationist literature: that so complex a world could not have arisen by forces operating by random chance. Similarly, Rea (1981) uses optimal foraging theory as evidence of design by an omniscient creator.

Creationists picture evolution as a threat to all aspects of their religion—not just to their folk science. Disbelief in the Bible, they say, leads inevitably to disbelief in God and eventually to social and moral decay. Morris (1974a:219) lists six ways in which his perception of God is inconsistent with the theory of evolution (or, more accurately, with his perception of the theory). He feels that evolution contradicts God's omnipotence (why should God create the universe gradually when he could have done it instantaneously), his personality (his desire to be worshipped not having been fulfilled for many aeons), his omniscience (trial and error evolution being neither wise nor efficient), his purposiveness (creating man by a roundabout route), his grace (by condemning the less fortunate), and his loving nature (survival of the fittest being rather cruel and heartless; apparently Morris considers floods kinder). Ingram adds that "the very notion of authority . . . hangs on the truth of creation and an understanding of it" (1977). Morris also criticizes nonliteralist interpretations of the Bible partially by quoting New Testament figures (especially Jesus) as having regarded the book of Genesis as literally true (Morris, 1974a:242–247). Saying that the infallible Christ was wrong about this point would call his entire divinity into question (*see* also, Williams, 1983).

Discussions of the mundane moral side of the controversy figure prominently

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in creationist writings. Morris himself exemplifies the way in which one's religion can influence one's decision-making process. He writes that he even majored in hydrology for the express purpose of studying Noah's flood and establishing its actual occurrence (1984). He believes that evolution gives students a negative view of themselves, their origins, and their destinies, thus leading to poor mental health and ultimately to "anti-scientific" solutions to their problems, such as drugs, astrology, witchcraft, and so forth (1974a:1–4). Awareness of the impending judgment, according to Morris, acts as a stimulus toward moral, responsible behavior, whereas students who are taught that they are descended from apes will behave like apes. One of the primary values of his books, he asserts, is that "the student can be led into a comprehensive, coherent, and satisfying world-view centered in his personal Creator and Savior, the Lord Jesus Christ" (1974a:15). He adds:

> Once man has rejected the Bible and other religious authority, there is no more divine constraint toward honesty or purity or charity or any of the other ethical values associated with divine revelation. [1974b:34]

Creationists frequently attribute many, if not all, of the world's ills to the spread and acceptance of the theory of evolution. Morris, for example, blames evolution for the declining morality of present-day society, attributing to it the rise of every anti-Christian philosophy of the twentieth century, as in the passage cited at the beginning of this article. Tim LaHaye (in Morris, 1974b:5) writes:

> Accepting man as animal, [evolution's] advocates endorse such animalistic behavior as free love, situation ethics, drugs, divorce, abortion, and a host of other ideas that contribute to man's present futility and despair.

Morris even goes so far as to trace the history of the idea of evolution back to the supposed indoctrination of Nimrod by Satan at the Tower of Babel (1974b:66–76). Klotz (1971; 1984) blames evolutionists for the current ecological crisis since, in his view, the theory of evolution teaches that people have a right to eliminate species which cannot compete with our own. Creationists, Klotz says, seek not to upset the divinely inspired balance of nature (thus ignoring the biblical admonition, "Go forth and multiply and subdue the Earth," which has influenced Christian thinking about the environment for two thousand years).

This perception of attack from all sides and the uncompromising nature of the literalist position is the ultimate reason for the creationist controversy and the

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reason it is not likely to disappear quickly from the political arena. It even promises to be around longer than the dispute over the heliocentric theory of the solar system.

Creationism versus Humanism

It should be pointed out, of course, that the creationists portray evolutionists in much the same light. They maintain either that the theory of evolution is a dogmatic religion conflicting with the true word of the creator (Zimmerman, 1976) or that it is a central tenet of the religion of secular humanism and, as such, on equal footing with creation. Duane Gish, for example, writes:

> They have combined this evolution theory with humanistic philosophy and have clothed the whole with the term "science." The product, a nontheistic religion, with evolutionary philosophy as its creed under the guise of "science," is being taught in most public schools, colleges, and universities of the United States. It has become our unofficial state religion. [1978:26]

According to creationists, one must either be a Christian and a creationist or a secular humanist and an evolutionist; there is no middle ground. In this they are as dogmatic and uncompromising as some extreme atheist organizations. Both groups decry the moderate positions of modernism and Christian humanism espoused by many contemporary churches. They take a dim view of the scores of mainline denominations, including the Roman Catholic church and many of the larger Protestant denominations, which have decided either to accept or ignore the theory of evolution and concentrate on the moral side of their religion rather than struggle to cling to literal interpretation of mythology several millennia old. The creationists have thus entrenched themselves in their positions and isolated themselves from a large part of society in much the same manner as the flat-earthers. Only the currently favorable political climate keeps the movement as vibrant as it is now.

The charge that evolutionists are dogmatic in their beliefs may have a grain of truth, at least for some scientists. Many assertions about evolution as an "established fact" have been printed and are sincerely believed by many scientists. Researchers, after all, are human and as much in need of certainty about their world views as anyone else (Seachord, 1984). Such statements are, however, exaggerated and play directly into creationist hands. Ideally, scientific theories should never be regarded as "proved" and should always be considered on "semiprobation" pending the acquisition of new evidence (Feibelman, 1972). Theories are useful to the extent that they explain the facts of nature. Evolution continues to be accepted by scientists because it is extremely powerful in explaining innumerable

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natural phenomena (Kitcher, 1982). Controversies concerning various details about the history of life on the planet abound in the scientific literature, and our understanding of past events is constantly changing due to new evidence. The theory of evolution remains the most useful framework for providing hypotheses. This adaptability is the main strength in the scientific method and the primary attribute which separates true science from folk science. Creationists cannot alter their beliefs since they are committed to a specific literary passage.

Conclusions

Those of us who have come to accept the theory of evolution have a responsibility to counter creationist beliefs not only on their chosen battlegrounds, such as debating fine points of esoteric scientific theory, but also by expanding the controversy to include those fundamental issues of morality and philosophy which lie at the root of the problem. We need to show the public that it is indeed possible to be a warm, caring, loving person and to feel good about life and have hope for the future without giving literal credence to age-old mythology. Morality in twentieth or twenty-first century society is no more dependent upon Earth's age or the age of our own species than it is upon the shape of Earth or the motion of the sun. Regardless of how the human race came into being and how it acquired its intelligence and sense of morality, the fact remains that these do exist and that we must satisfy our social and psychological needs, both individually and collectively. The theory of evolution can play much the same role as traditional mythology in answering psychological needs and justifying one's world view (Seachord, 1984).

Byers (1984) argues for cooperation rather than confrontation between science and religion so that both may benefit. Gilkey (1982) goes a step further, holding that religion and science have never truly been in conflict, that both permeate all aspects of society in different ways. I agree. Worthwhile modern religion, regardless of its sacred symbolism, need not be bound by anachronistic perceptions of nature, especially in an age when science is constantly expanding the frontiers of knowledge. Rather, it should adapt to changing conditions and grow with the truly awe-inspiring advances in understanding. Static folk science may have sufficed in a slower-changing culture, but it can be deleterious for modern civilization. Religion should help individuals and societies cope with the scientific advances and strive to ensure that the fruits of this labor are used for moral purposes rather than deny that such advances exist.

Science, likewise, must continue to take its inspiration from honorable religious principles. Many books have been written on scientific ethics and at least two entire journals are devoted to the subject, *Environmental Ethics* and *Science, Technology, and Human Values*. Most of the writings share a certain core of ethical criteria, involving primarily a profound respect for life—human or otherwise. There

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is nothing implicit in scientific investigations of nature which require these values; it is essentially a religious issue and reflects the interface between the two realms of human endeavor. Despite the multitude of rhetoric and distrust between various religious groups, and despite significant differences in detail and interpretation, most contemporary religions do share a fundamental core of basic beliefs. It may do us well to emphasize the similarities instead of the differences.

The sacred symbols used by scientists in their own religious philosophies can take many varied forms. Many excellent scientists are devout theists, presumably taking their inspiration from the desire to "think God's thoughts after him." Others have drawn their strength from the ideal of doing the greatest possible long-term good for the human race, an ideal which forms the basis of contemporary humanism (Lamont, 1982). Capra (1984) argues for an essential unity between subatomic physics and Eastern mysticism. Even among those religions whose symbol is a deity, the particular form of the belief can vary widely. The vision of an anthropomorphic entity controlling the course of worldly events and condemning those who stray from the prescribed path is hardly universal even among theistic religions. Some Christian groups equate the term *god* with such concepts as *love* or *nature*, maintaining that this should be the basis for human moral behavior, or use the word to symbolize the deepest human needs and desires (for example, Barth, 1948; Eliot, 1928). Most contemporary churches feel compelled to retain the theistic terminology of past generations for reasons of historical continuity (with a few exceptions, such as Unitarian Universalism), but their characterizations of their deity have evolved considerably since the *Origin of Species*. Many of those who argue for the incompatibility of religion and evolution (for example, Provine, 1982) refuse to acknowledge this variety in theistic thought. They define the terms *religion* and *god* so narrowly as to include only those ideas with which they disagree.

The exact form of the symbolism and the metaphysical expression of the beliefs are to a certain extent irrelevant, since ethics and psychology form the basis of religion, and the symbolism serves only as a rationalization of the belief system. As long as scientists use their particular faith as a source of inspiration to discover more about nature rather than as a force dictating their findings, and as long as the results of scientific investigation are used in an ethical manner, there is no conflict between science and religion whatsoever. The danger lies in tying one's faith to a falsifiable dictum, as have the flat-earthers and the creationists.

It may well prove to be difficult to convince some fundamentalists of this need for cooperation, as it may involve changing long-held and deep-seated distrust and misconceptions of science and scientists in many parts of the country. The negative fundamentalist view of human nature also represents a significant obstacle.

> Liberalism espouses a doctrine of "progress," based on man's innate potentialities for development, a doctrine which implicitly denies the fact of man's Fall and basic depravity. [Morris, 1963:19]

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Hence, Christianity, in Morris's view, is inimicable to social progress. It certainly need not be.

The adoption of the creationist theories and dogmatism would negate many of the scientific advances of the past two centuries and stifle any further scientific and technological progress. To do so would be to condemn future generations to ignorance and halt the human race's struggle to improve its own existence. This is the ultimate moral question involved in the creation-evolution controversy.

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"Sun, Stand Thou Still": An Astronomical Critique of a Creationist Biblical Chronology

by William H. Jefferys

Every so often one hears that a NASA computer calculating past motions of the planets came to a stop at about the time that Joshua commanded the sun and moon to stand still in the sky (Joshua 10:12). This story has been cited by some as "proof" of the literal truth of the Bible. As far as I know, no one has ever documented that this actually happened at NASA, but the story has been repeated frequently (McIver, 1986).

Some time earlier, Karl Fezer, editor of *Creation/Evolution Newsletter*, was sent a copy of E. W. Faulstich's manuscript, "Moses the Astronomer and Historian Par Excellence," which was purported to contain a computer "proof" of the reality of Joshua's "long day." Faulstich is the founder of the Chronology History Research Institute (CHRI) of Rossie, Iowa. CHRI is a publisher of books, tracts, charts, and newsletters on biblical chronology. It has close ties with the Genesis Institute, founded by well-known creationist Walter Lang, founder of the Bible Science Association.

I, along with E. M. McCollister, Philip R. McLean, and Ronald G. Tabak, was asked to evaluate the manuscript. We soon determined that it was not at all connected with the story about the NASA computer. However, since Faulstich's paper generated much interest among creationists, a thorough evaluation of his paper seems in order.

His manuscript describes a rather intricate biblical chronology which he developed to tie together astronomical events and a luni-solar calendar. Faulstich claims to show that the planets were created on Wednesday, March 22, 4001 BCE, at 6:00 PM, or thereabouts, Jerusalem time. At this instant, he says, there was a close conjunction of Mercury, Venus, Mars, and the moon, as seen from Earth,

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and he believes that God created the planets in this configuration on the fourth day of creation.

Starting from this point, Faulstich alleges that he has established from the Bible the precise dates on which certain events happened. He asserts that the Bible gives him not only the year, month, and date of these events on the Hebrew calendar but also the day of the week for each of twenty events. His paper ends with a computer program to calculate dates on the Hebrew calendar, as well as the corresponding days of the week. According to him, he obtains perfect agreement with these twenty events. He says that this agreement confirms the literal truth of the Bible.

I find a number of problems with his work which are described in detail below.

Biblical Chronology

The first, obvious test to apply to Faulstich's work is to see how well his chronology agrees with what archeologists and biblical scholars have determined after many decades of exhaustive research. Since Faulstich claims that his chronology derives from a completely literal reading of the Bible, each of the dates within his chronology is absolutely fixed relative to all the others; thus, even a small discrepancy would mean that the biblical date of creation would not coincide with the planetary configuration crucial to his theories.

In constructing a biblical chronology, it is reasonable to adopt the working principle that events recorded in the Bible are not isolated but are set in a much larger context of Middle Eastern history. Insofar as biblical events are historical, they should be subject to the same scrutiny used by historians to evaluate any historical event. For example, not only should dates derived from biblical data be internally consistent but also, whenever synchronisms with reliable extrabiblical data can be established, they should agree with the external data. In case of conflict between several sources, greater weight must be accorded to those sources which are judged to be more reliable.

It is difficult to establish absolute chronologies of the Bible without referring to external events, because the Bible does not give us the years in which certain events occurred in a system that is readily related to world history. This is not true for Egyptian and Mesopotamian history. Particularly in the case of Mesopotamia, a large number of original documents from the first and second millennia BCE have been unearthed in the form of cuneiform records on baked clay tablets and monument inscriptions. Since these documents are contemporaneous with the events they describe, they must weigh heavily indeed in the historian's balance of evidence. Many of these documents can be dated absolutely on the basis of astronomical events, and scholars have established a highly reliable chronology of Mesopotamian history for the first millennium BCE (DeVries, 1962).

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A number of precisely dateable records refer by name to contemporary Hebrew kings. For example, Assyrian documents from the reign of Shalmaneser III record that the King Ahab of Israel fought in 853 BCE at the Battle of Qarqar. Twelve years later, in 841 BCE, the "Black Obelisk" of Shalmaneser III pictures Jehu, king of Israel, paying tribute to the Assyrian king. A century later, both the Bible (II Kings 15:19) and Assyrian records record that Menahem of Israel paid tribute to Tiglath-pileser III, who reigned from 745 to 727 BCE. Later Babylonian records establish that Nebuchadnezzar II captured Jerusalem in 597 BCE. From this, one can establish that the destruction of the temple in Jerusalem took place in 587 or 586 BCE, which is how authorities date it today.

How do these records agree with the dates given in Faulstich's paper? The answer is, not well at all. To start with, Faulstich dates the destruction of the temple in 588 BCE, at least one and possibly two years too early. While one can argue that the temple was destroyed in 587 (this turns on a technical point as to whether the kings of Judah began their reign-years in the spring or the fall), Faulstich's date of 588 conflicts with the biblical record (Jeremiah 32:1; II Kings 25:8) that the siege of Jerusalem was in progress during the eighteenth and nineteenth years of Nebuchadnezzar's reign. Nebuchadnezzar's eighteenth reignal year is known to have begun in the spring of 587 (Parker and Dubberstein, 1956).

As we go back in time, the discrepancies become greater. For example, according to Faulstich, King Menahem died in 752 BCE, seven years before Tiglath-pileser III ascended the throne. This conflicts with the records which state that Menahem paid tribute to Tiglath-pileser III. Again according to Faulstich, Ahab died in 869 BCE, sixteen years before he is recorded as having fought at Qarqar. Faulstich claims that the battle was actually fought earlier. These are several of a number of major discrepancies. The net result is that Faulstich's chronology is between fifteen and twenty-four years too early at the time the divided kingdom of Israel and Judah was established (between 931 and 922 BCE, according to modern scholarship).

Now, one could argue that these external synchronisms are inconsistent with the Bible and should be ignored. I think that is a difficult position to defend. One reason is that they are *not* inconsistent with the Bible. It is true that biblical chronology of the period is difficult; for example, if one simply adds up the reign-lengths of contemporaneous kings of Judah and Israel, one finds that equal intervals of time do not agree between the reckonings of the two kingdoms. One reason is that Judah and Israel counted the years in a king's reign differently. In Israel, the king was allowed to count the year of his accession as the first year of his reign; in Judah, the first year of the reign was counted from the *following* new year. This means that in Israel, the last year of the old king's reign was counted twice, once in each king's reign. This leads to counting too many years when the total reigns of several kings are added up. An example is given by the reigns of Ahab and Jehu. Between Ahab and Jehu there were two kings whose total number of

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reign-years adds up to fourteen. But we already know that Ahab was still king in 853 and that Jehu was king twelve years later in 841. The excess of two years is attributed to the double counting of two years in the official count of Israel. Other questions that have to be resolved for each kingdom involve whether the reign years began in the spring or the fall and what method each kingdom's chroniclers used to report dates affecting the other kingdoms. An additional complication comes from the fact that several of the kings established coregencies with their successors, so that some years are counted double that way.

Despite these difficulties, the general outlines of the chronology of the Divided Kingdom have been worked out to the satisfaction of most scholars (Bright, 1981; Thiele, 1965). Presently accepted chronologies sometimes differ by a few years, but they are internally and externally consistent and have withstood the test of time (Hallo, 1964). It is unlikely that these chronologies are in error by as many years as Faulstich's chronology would require.

To be fair to Faulstich, he is very aware of the problems his chronology faces as a result of archeological facts. Indeed, he has written a book on the subject, *History, Harmony, and the Hebrew Kings* (1986), in which he attempts to account for them. Arguments in his book are unconvincing. Accepting them would mean abandoning a large and compelling body of evidence. Ironically, the archeological evidence that Faulstich tries to discredit is precisely the same kind of corroborative evidence that other fundamentalists point to as evidence that the Bible is a reliable historical record.

If we were to accept the relative dating given by Faulstich between the creation and the establishment of the Divided Kingdom but were to correct the starting point to agree with modern scholarship, it would be necessary to move his creation date up by fifteen to twenty-four years. This means that Faulstich's creation date is at least fifteen years too late to have occurred at the time of the astronomical conjunction he cites.

And things get even worse when we consider the dates of the Exodus, which Faulstich places in the fifteenth century BCE. While the issue is not absolutely settled, a number of lines of reasoning lead most scholars to conclude that the Exodus took place in the thirteenth century BCE rather than the fifteenth, which one gets by naively counting backwards from the building of the temple by Solomon (De Vries, 1962; Freedman in Wright, 1961; Rowley, 1950). Among these reasons are the fact that, according to Exodus 1:11, the oppressed Jews in Egypt were forced to build the cities of Raamses and Pithom, which are known to have been built in the thirteenth century; the fact that many of the walled cities of Canaan mentioned in the Bible are known to have been destroyed in the thirteenth century (presumably by invading Hebrews); and the fact that the Bible does not mention Egyptian incursions into Palestine in the period between the Exodus and Solomon, although it is known that the Egyptians were pursuing an aggressive military foreign policy in the region in the late fourteenth and early thirteenth centuries. The over-

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whelming weight of the evidence, according to scholars, is that Ramses II (1301–1234 BCE) was the pharoah of the Jewish oppression in Egypt and that the Exodus took place during his reign or soon afterwards.

This date for the Exodus conflicts with the biblical reckoning of 480 years from the Exodus to the building of the temple given by I Kings 6:1. However, the figure of 480 years also conflicts with other biblical data. For example, the number of generations listed in the Bible from Moses to Solomon is only six (Exodus 6:23; Ruth 4:20–22), which is much too few for such a long period. So it is unwise to accept the 480-year figure uncritically. It is virtually certain that this figure was obtained by later chroniclers multiplying a conventional forty years per generation by twelve generations and that the actual amount of time was much smaller (De Vries, 1962; Freedman in Wright, 1961).

If we accept this argument and Faulstich's pre-Exodus relative chronology, then the astronomical conjunction cited by Faulstich occurred approximately two centuries before the planets were created.

Calendrical Matters

But suppose we ignore these problems and accept Faulstich's chronology for the moment. What of his next claim that the biblical dates and days of the week agree perfectly with the astronomical facts? Faulstich gives an example:

> If, for example, Moses read the Law on the first day of the 11th month of the 40th year on a Saturday, the lunar-solar calendar for 1422 BC can be examined to see if the text is correct. . . . Some 20 dates studied have been found to be correct. Calculating the chances, we have seven days in a week, therefore the first date would suggest one in seven, the second 1/49, the third 1/243, the fourth 1/2401, etc. The probabilities of 20 being correct by chance would be some 97 billion to one.

Three questions have to be answered. First, can one really derive these dates from biblical data alone? Second, do the dates and days of the week given by Faulstich really coincide? And finally, if they do coincide, what is the most likely reason for this?

Faulstich cites a number of biblical passages in support of his first claim. I have examined them and find that, although in many cases there is information that would allow the month and day on the luni-solar calendar to be determined, there is little information that would allow one to determine the day of the week. I wrote to Faulstich about this. He gave in support of his contention that Moses received the Ten Commandments on a Saturday both Jewish tradition and Exodus 24:16 (NEB), which states: "The glory of the Lord rested upon Mount Sinai, and

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the cloud covered the mountain for six days; on the seventh day he called to Moses out of the cloud.'' Faulstich interprets ''seventh day'' to mean ''Saturday.'' When I pointed out that it could just as well mean the seventh day after the previously mentioned event, he responded that the Jews used numbers to count their days. Perhaps, but I find this rather flimsy evidence. I note, for example, that Exodus 19:16, which refers to the same event as does Exodus 24:16 (Gray, 1971), says that, just before Moses climbed up the mountain to receive the law from God: ''On the third day, when morning came, there were peals of thunder and flashes of lightning, dense cloud on the mountain and a loud trumpet blast; the people in the camp were all terrified.'' If Faulstich's interpretation were correct, then this passage would have to be interpreted as saying that Moses went up to receive the law on a Tuesday, not a Saturday.

Giving Faulstich the benefit of the doubt, we can press on and ask if the dates he gives are consistent with the ancient Hebrew calendar. I find that they are not. The Hebrew calendar in use during biblical times is different from today's version. Today's calendar is based upon a conventionalized calculation of the positions of the moon and sun which is fairly straightforward, despite some special rules (dehioth) which prevent certain holy days from occurring on certain days of the week (Spier, 1952). However, in biblical times, even as late as the first century of the Common Era, the first day of the Hebrew month began at sunset on the first day that the crescent of the new moon was visible before sunset. If the moon was not *actually seen* before sunset on the day of the new moon, the beginning of the month was postponed until the following day. It follows (since the average length of time between one new moon and the next is 29.53 days) that a Hebrew month in ancient times was either twenty-nine or thirty days long.

This method was in general use in many parts of the Middle East for thousands of years. One consequence of this method of determining the beginning of the month is that the day on which a given lunar month began cannot be determined with mathematical certainty since bad weather may have prevented priests from actually observing the lunar crescent on the first day that it could theoretically have been seen. Nor is weather the only consideration; poor visibility conditions in the Fertile Crescent near the horizon make the new moon easy to miss even in good weather (Neugebauer, 1951). Therefore, when the sighting was delayed, for whatever the reason, the preceding month automatically had thirty days—regardless of the astronomical facts. Many such instances are known from cuneiform records (Landon and Fotheringham, 1928).

Even assuming perfect weather, it is not simple to predict the time of first visibility of the lunar crescent. The time between actual new moon and first visibility depends, among other things, upon the observer's latitude and longitude on Earth, the time of the year, the position of the moon in its orbit, and the constantly changing orientation of the moon's orbit. This has been investigated extensively because many of the cuneiform records give sufficient information for the lengths of par-

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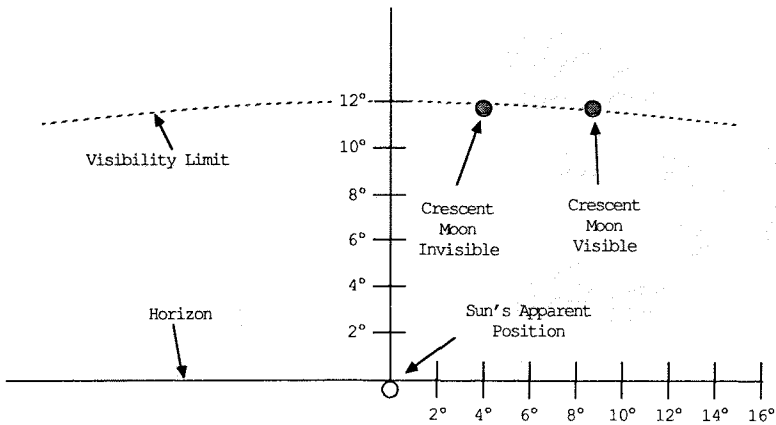

Figure 1: Prerequisites for observing the new moon's crescent. At the instant that the sun appears to slip below the horizon, the center of the moon (uncorrected for refraction) must lie above the dotted line.

ticular months to be determined. The work of Fotheringham (1910) and Schoch (Langdon and Fotheringham, 1928) has made it possible to determine mathematically the earliest moment at which the crescent moon might be visible. Even though uncertainties due to weather and observing conditions near the horizon still cannot be resolved, these scholars have obtained excellent agreement between the cuneiform records and independent calculations. The moon must stand high enough above the horizon at the moment of sunset (as illustrated in Figure 1) or it cannot be seen with the naked eye. The moon will be visible (given good weather and atmospheric conditions near the horizon) only if its center is higher than the dotted line at the instant that the sun's upper limb disappears from view below the horizon.

Faulstich, on the other hand, has used a very simple mathematical model to determine the beginning of months in the Hebrew calendar. He has assumed that the moon moves at a constant velocity around Earth instead of at a significantly varying orbital velocity. His model also fails to take into account the fact that the moon is constantly moving farther from Earth (by about four centimeters per year), so that the month is getting longer, and, moreover, it fails to consider the significant slowing of Earth's rotation by the tides. Faulstich's computer program makes no attempt to determine the moment of first visibility of the lunar crescent as illustrated in Figure 1, nor does it take into account the substantial influence of the observer's longitude and latitude on the moment of first visibility. Finally, Faulstich's method is mathematically deterministic and therefore inherently unrealistic because it takes no account of possible problems with weather or atmos-

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pheric conditions near the horizon.

I find that many of the months in which Faulstich has dated events cannot have begun on the days he calculates. For example, his date for Moses reading the law (quoted previously) is Saturday, on the first day of the eleventh lunar month of the luni-solar year 1422–1421 BCE. I find that at sunset on the preceding Friday, the moon was still too close to the sun to have been visible anywhere in the Sinai peninsula or its environs (including Jerusalem), where the events reported are supposed to have taken place. Therefore, the first day of the eleventh lunar month of that year cannot have been a Saturday. The very earliest it could have been was a Sunday. Indeed, it could even have been a Monday if visibility conditions on Saturday were poor. Therefore, if Faulstich's identification of the day of the week is correct, the event could *not* have taken place in the luni-solar year 1422–1421 BCE. Since this is a key "anchor" date, Faulstich's entire chronology is put in jeopardy.

One can go even further and state that, *if the dates and days of the week had agreed with Faulstich's calculation, then they must have been calculated, not observed.* This is so because Faulstich's dates are inconsistent with the astronomical facts but consistent with a simple lunar ephemeris in which the moon moves at a uniform rate. Since it is not until quite late (c. 500 BCE) that the ancients were able to *predict* some of the astronomical events that are required for a successful luni-solar calendar (Neugebauer, 1955, 1975), it follows then that *these dates would have to have been incorporated into the Bible after 500 BCE*, which would contradict Faulstich's assertion that Moses himself wrote these books. Scholars have known for over one hundred years that Moses was not the author of the Pentateuch (the so-called Five Books of Moses); these documents were the product of many hands and were written down between the tenth and fifth centuries BCE, although they recount traditions that are much older. Strict fundamentalists are virtually alone today in accepting the Mosaic authorship of the Pentateuch (Hyatt, 1971).

Joshua's Long Day

Faulstich claims that he has evidence that the "long day" in the Bible, when Joshua commanded the sun to stand still, really took place. His argument goes as follows: according to astronomical calculations, the conjunction in 4001 BCE took place on Thursday morning at about 6:00 AM Greenwich. According to Faulstich's ideas, the conjunction should have happened when God finished creating the planets on the evening of day four (Wednesday). Therefore, the creation of the planets occurs a half-day too early. He proposes that the half-day discrepancy is due to there having been an extra-long day in Joshua's time.

Unfortunately, there is at least one fly in this ointment. If there had been an extra-long day in Joshua's time, the effect would have been to move the cre-

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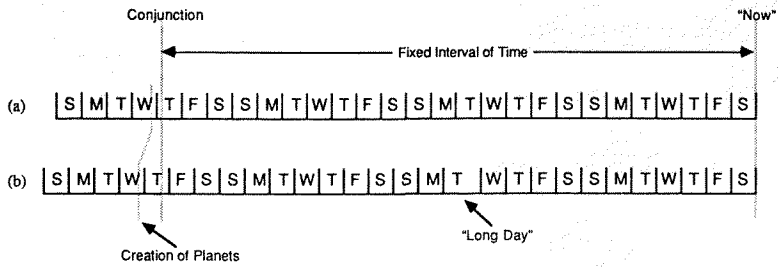
Conjunction
"Now"
Fixed Interval of Time
(a)
S M T W T F S S M T W T F S S M T W T F S S M T W T F S
(b)
S M T W T F S S M T W T F S S M T W T F S S M T W T F S
"Long Day"
Creation of Planets

Figure 2: Insertion of half a day makes the creation of the planets move to an even earlier time relative to the conjunction. (*a*) The upper calendar shows the situation without a "long day." (*b*) In the lower calendar, all days before the day which is lengthened must begin a half day earlier. The conjunction now takes place on Thursday afternoon.

ation of the planets to an *even earlier time*, relative to the alleged significant conjunction. This is easy to see. Assume, as does Faulstich, that the motion of the moon and planets gives us a very good clock. This means that the interval of time between two events involving the motion of these bodies (measured in what astronomers call "Ephemeris Time") is fixed and unchanging. For example, the interval of time between Faulstich's conjunction and "now" (the present instant) is fixed.

If we make one of the days between the conjunction and "now" longer by half a day, the interval of time between the creation of the planets and "now" becomes longer by half a day. Since recent dates are unaffected, it follows that the additional time must be accounted for by moving the creation of the planets to an *earlier* instant. This is illustrated in Figure 2.

The effect is the exact opposite of what happens when we remove time from the chronology. Earlier we found that if we *removed* fifteen years from the chronology of the Divided Kingdom, the date of creation would be moved to an instant fifteen years *later* than the astronomical conjunction. Likewise, if we *add* half a day in the form of "Joshua's long day," the date of creation would be moved yet another half a day *earlier*, relative to the conjunction. Since Faulstich's creation day is already too early, this makes matters worse for his theory, not better. To move the moment of planetary creation to a later time, he would have to *remove* a half day by making Joshua's day *shorter*. This, of course, would be biblically unacceptable, even though the hypothetical changes are very small scale.

It should also be noted that the same thing would happen to all of Faulstich's lunar dates prior to Joshua. With an additional half-day inserted, the new moons would occur later on the day count, not earlier, and would postpone the beginning of still other months to later days in the week. This, in turn, would exacerbate

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Table I

Conjunctions of the Moon, Mercury, Venus, and Mars

Julian Ephemeris Day	Conjunction Half-width (°)
211743.00	0.46
260173.03†	0.65
288227.26	0.71
350654.31	0.83
494911.41	0.97
539326.29	0.34
651544.26	0.44
667903.96	0.95
708624.38	0.26
1033077.15	0.73
1105459.27	0.28
1239790.76	0.53
1264627.68	0.37
1440924.30	0.76
1561112.07	0.91
1573487.42	0.60
1705369.35	0.83
1721729.30	0.63
1766856.02	0.86
1798213.94	0.85
2049312.87	0.43
2159198.35	0.56
2256707.55	0.84
2388589.98*	0.26
2519501.70	0.80
2556917.46	0.77
2571915.50	0.63
2588275.40	0.75

† Faulstich's Conjunction
* August 21, 1827

Faulstich's problem of making his chronology agree with the days of the week.

When I pointed out this difficulty to Faulstich, he responded that perhaps only the sun and moon stopped and that perhaps the motion of the planets was not affected. This idea doesn't work either. The planets move very slowly against the background of the stars, so the time of the conjunction is determined almost entirely by the motion of the moon and is hardly affected at all by the motion of the planets. With this modification, the conjunction remains stubbornly fixed on Thursday morning.

Faulstich provides a simple computer program for calculating the Hebrew date that makes a correction for the half (actually, 0.4) day. Unfortunately, the correction is applied with the wrong sign. Indeed, the program would not even run as printed! Faulstich later provided me with some programs written in Applesoft BASIC which did run correctly, apparently programmed by an associate of his. One was a program for calculating dates on several calendars, while others calculate lunar and planetary positions with reasonable accuracy. Biblical exegesis was not materially affected.

How Rare Are Conjunctions?

The *width* of a conjunction or alignment is the difference between the *largest* and the *smallest* geocentric longitude of the four bodies involved. In his paper, Faulstich states that the odds against a one-degree (half-width) alignment of the moon, Mercury, Venus, and Mars are 16,796,160,000 to one. He doesn't actually say that this is per year, but from the context it is clear that

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this is what he means. The alleged rarity of this phenomenon is a major part of Faulstich's argument that the planets must have been created at that time.

I calculated that the actual odds in any year were of the order of a few hundred to one. When I pointed this out to Faulstich, he expressed doubt that I was correct and challenged me to find other similar alignments. As it happened, I had already done so. The dates and half-widths of the alignments I found are shown in Table I. (These alignments given in the table after 1410 BCE have been checked independently by E. M. Standish of the Jet Propulsion Laboratory using the JPL Ephemeris DE 102, which is the current standard ephemeris. Agreement between my calculations and his is excellent.) The times of the events are given as the Julian Ephemeris Date (*not* the Julian Date) of the configuration. My search covered the seven-thousand-year period from 4500 BCE to 2500 BCE. I found twenty-eight such alignments, or an average of one per 250 years. Of these, thirteen, or one per 538 years, are *closer* than the one cited by Faulstich. It is evident that quadruple conjunctions like the one in 4001 BCE are not rare at all. Faulstich has overestimated the odds against such a configuration by a factor of at least 3×10^7.

For example, the conjunction of August 21, 1827, had a half-width of only 0.26 degrees, just four-tenths that of Faulstich's conjunction of 4001 BCE. Surely if Faulstich's ideas were correct we would expect to find that something spectacular happened on that date, something much more wonderful than the creation of the planets! As far as I can determine, however, that day was just an ordinary day in history, indistinguishable from any other hot day in August.

Conclusions

I have demonstrated that Faulstich's conclusions conflict with both biblical and extrabiblical historial evidence and with astronomical and calendrical facts. Contrary to Faulstich's claims, the planetary alignment upon which he bases his conclusions is in no way unusual. Although the motto of Faulstich's CHRI is "Stressing Truth Through Scientific Methods," it is hard to see how the arguments he presents in his paper can be called "scientific." Scientifically, conjunctions are of interest only if they provide special observing conditions, like eclipses, and to accord them greater significance smacks of astrology and numerology, not science. Surely one must come up with more than this to refute the overwhelming scientific evidence that exists for the great age of Earth.

However, Faulstich deserves credit for one aspect of this work. His idea of using a modern computer program to determine ancient dates on the Hebrew lunisolar calendar has merit, even if it is not as straightforward to apply as he thought and even if its execution was flawed. However, I personally believe it unlikely that many dates can really be pinned down with this technique, since the notion

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that the Bible is a historical record that provides the required information with sufficient reliability for this to be done is suspect. As Neugebauer has shown, even the interpretation of ancient documents such as original cuneiform astronomical tablets requires great care, and a similar analysis of a document such as the Bible would be perilous indeed.

Acknowledgements

I thank Eugene W. Faulstich for his assistance in answering my questions about his work. Despite the fact that I did not hide my skepticism about his theories, he has been a willing and courteous correspondent and has provided more than I asked for. I also thank Frank Arduini, John Cole, Karl Fezer, E. M. McCollister, Philip R. McLean, and Ronald G. Tabak who provided valuable commentary.

Special thanks are due to Prescott Williams, professor of Old Testament languages and archeology at the Austin Presbyterian Theological Seminary, who gave me valuable insight into Old Testament chronology and suggested some important sources of which I was unaware.

Finally, I thank Robert J. Schadewald. His very careful reading of this manuscript and his correspondence with me about Faulstich's work has been invaluable.

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Tracking Those Incredible Creationists—The Trail Goes On

Ronnie J. Hastings

The following is another installment of the enthnography and analysis of Paluxy River mantrack claims in Texas traced through *Creation Evolution* XV and XVII (Hastings 1985, 1986).

March 1986. In the "News and Views" section of *Nature*, Australian Tony Thulborn assessed the positive impact John Morris's admission that the "best" of the creationist "mantracks" were dinosaurian would have in exposing creationism (Thulborn, 1986). But the admission was coming somewhat qualified from the Institute for Creation Research so as to keep alive hopes for hard-line "mantrack" enthusiasts. Despite his seeing the evidence for himself in October 1985 (Hastings, 1986), John Morris, in his subsequent *Impact* article on the Paluxy tracks, suggested that the color distinctions or colorations (also called discolorations) which clearly revealed the "mantracks" to be dinosaurian were only surface phenomena—perhaps the result of painting or staining (Morris, 1986a). He proposed the mechanism of using hydrochloric acid and iron sulfate but failed to point out what a task it would be to paint the well over 120 colorations now documented by Kuban and me.

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Furthermore, Morris had access to cores taken at the Taylor site in November 1985. Both John Makay of Australia and Paul Taylor had aided in getting these cores, each of which measured one-and-one-half inches in diameter. These presumably had been taken to gain insight into how the colorations formed, but Morris had little to say about them except that they were "inconclusive."

The Reverend Carl Baugh, whose activities and support around the Creation Evidences Museum near Glen Rose, Texas, had noticeably diminished since 1982, attempted in the spring of 1986 to excavate some previously purchased land downriver from the Taylor site to find new tracks. Despite spirited reports of bulldozers and plans to use dynamite, this revival of Baugh's "research" dwindled by July, leaving a badly scarred and exposed riverbank dug only a fraction of the way to the track level just upstream from the state park. Curiously, Baugh returned to the submerged Taylor site, attempting to sandbag and expose parts of the Giant Run trail.

Late April 1986. Glen Kuban published a summary of the results of the research he and I had carried out on the Taylor site in *Origins Research*, the publication of the creationist organization, Students for Origins Research (Kuban, 1986a). Bristling with many of Kuban's photos, this issue effectively debunked past creationist mantrack claims from within the creationist press. Neither John Morris of ICR nor Paul Taylor of Films for Christ could reply with anything beyond what had been implied in Morris's *Impact* article (#151).

This was the second time *Origins Research* had shaken the foundations of the mantrack claims. Earlier, in the wake of *Creation/Evolution* XV, it had published an exchange between John Cole and creationist John DeVilbiss (Cole, 1985; DeVilbiss, 1985), which encapsulated the groundlessness of mantrack claims leading up to Kuban's and my work on the Taylor site.

May 30, 1986. John Cole gave an overview of creationist Paluxy "mantrack" claims as part of an afternoon session entitled "The Creation-Evolution Controversy: 1986 Update" at the annual meeting in Philadelphia of the American Association for the Advancement of Science. Bolstered by the recently published *Creation/Evolution* XVII, which carried articles by Kuban and me, Cole's presentation centered around slides, including some of Glen Kuban's latest from the Paluxy which I had provided. In Philadelphia, I found a general interest in obtaining copies of many of Kuban's slides; however, media interest in the significance of the colorations was surprisingly low, except for some of the foreign press, including newspapers in Sweden and Canada (Ogle, 1986).

Concurrently, Kuban, at the first annual International Conference on Dinosaur Tracks in Albuquerque, New Mexico, provided what paleontologist Jim Farlow called the "highlight" of the conference: a dual presentation of elongate dinosuar tracks and of color distinctions—the two phenomena considered responsible for

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the "best" of the creationist "mantracks." Paleontologists and dinosaurian ichnologists reviewed their own worldwide dinosaur trail data to find a heretofore little-noticed frequency of elongate tracks consistent with the dinosaurs "dropping down" on their "heels." Particularly devastating to Morris's suggestion of fraud were further discoveries soon after the conference of dinosaur tracks with colorations in both Colorado and New Mexico (Martin, 1986; Gillette, 1986).

June 3, 1986. My son, Dan, and I attempted to meet Farlow and a group of paleontologists on a post-conference field trip to Glen Rose, but unusually heavy rains dashed the chances of any riverbed observation and we arrived after their departure. As we witnessed the torrent of water roaring a couple of meters above normal, I wondered if the colorations at the Taylor site would be affected.

The efforts of *Creation/Evolution* triggered a torrent of media interest in the work Kuban and I had done and which had led to Morris's retraction about the "mantracks." An initial *New York Times* article on June 17 (Wilford, 1986) heralded the appearance of many other articles throughout the summer (Golden, 1986a; Boyer, 1986; Lemonick, 1986; Pugh, 1986; Long, 1986). Kuban, Cole, and I provided many of the accompanying photos.

John Morris responded to Thulborn's report in *Nature* with a letter repeating the fraud possibility and erroneously stating the relationship between the colorations and the shallow depressions sometimes associated with them on the Taylor trail (Morris, 1986b). Farlow, Cole, Kuban, and I responded with letters, the mildest of which was eventually published in condensed form (Farlow, 1986).

July 29, 1986. My wife and I arrived in Glen Rose to find that John Morris was present and working at the Taylor site, perhaps with Baugh. Anxious to meet Morris and talk with him, we drove to Jacob McFall's house on the bank of the Paluxy, where access to the Taylor site is the easiest. There in the McFall yard were Morris and a colleague from Oklahoma just returning from the river. Before I could even begin talking with Morris, the McFalls verbally evicted me from their property—an unexpected turn of events, as my relationship with them had been congenial until then. I could only surmise that their very latest associations with Baugh or their displeasure over *Creation/Evolution* XVII had caused this change. Before we left, I managed to make arrangements with Morris to meet him in Glen Rose.

Morris failed to meet with me, however. He drove by the appointed place at a local motel without glancing our way. After almost an hour waiting for him to return, I left him a hand-written letter via a motel clerk, to which he never responded.

July 30, 1986. Morris also failed to meet science writer Gayle Golden of the *Dallas Morning News* who had driven from Dallas to Glen Rose to keep the appointment. Undeterred, Golden traced Morris to the Taylor site where he was working with

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Baugh and others on the Giant Run trail.

What exactly Morris was looking for was never clear, though he was expressly tired of the whole mantrack affair (Golden, 1986b) and seemed uncomfortable working with Baugh. Perhaps he was looking for some significant information to take with him to the International Conference on Creationism being held in Pittsburgh the following week, at which he was scheduled to present something on the Paluxy tracks. Nonetheless, his behavior toward both Golden and me during these two days was not befitting someone who was interested in how the colorations could have formed. I, for one, could have given him lots of information.

August 4–9, 1986. Morris's behavior continued in the same vein at the conference. Kuban had been grudgingly given some time to report on the identity of the "mantracks." Kuban allowed Morris to borrow some of his slides, hoping that Morris would reciprocate by letting Kuban examine at least photos of Morris's cores. No reciprocation was forthcoming (Kuban, 1986c). Though virtually unpublicized during the conference, Kuban's presentation on August 8 prepared those who attended for the misinformation Morris presented the next day. Morris would have his audience believe that Kuban and the "Raiders of the Lost Tracks" (Godfrey, Cole, Schafersman, and Hastings) were heavily funded by organizations such as the American Humanist Association and that he had been accused by these investigators of having carved footprints—neither of which is true (Wakefield, 1986). Still calling his cores "inconclusive," Morris only very briefly displayed slides of them and did not allow anyone, especially Kuban and Cole, a good look at them. Morris overlooked such questioners from the audience as Cole and, after the presentation, pretended not to recognize Cole or to realize that *Creation/Evolution* XV and XVII answered many of his own questions about the Taylor site (Cole, 1986).

August 1986. By now, Kuban and I planned to get cores for ourselves—to obtain evidence whether the colorations were surface-only or subsurface—thereby settling once and for all the matter of possible painting or staining. So obvious had the genuineness of the colorations been to us that little had seemed needed for their analysis beyond the small surface chips I had taken in October 1985. These chips showed no unexpected geochemical features (Hastings, 1986) and indicated a material other than limestone below the track surface. But the comparative silence of Morris about his cores, coupled with the new professional interest in the coloration phenomenon, compelled us to take further action. Uncooperative weather (the Paluxy was unusually high for August), Kuban's lack of traveling funds, and a medical emergency in my own family combined to postpone our efforts. However, we did locate and obtain a small, portable coring tool.

Two of the "Raiders," Laurie Godfrey and John Cole, published in *Natural History* a concise overview of creationist "mantrack" claims, citing the colorations as part of the explanation of why the Taylor site tracks are dinosaurian

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Godfrey, 1986).

Meanwhile, BBC producer Jeremy Taylor, through contacts with Cole and me, was arranging to film part of a documentary featuring the exposure of creationist "mantrack" claims along the Paluxy. He represented the Horizons division of the BBC, the producers of the British-made episodes of "Nova" on PBS. A preliminary trip to Glen Rose in early August verified for Jeremy Taylor that the Paluxy/Glen Rose setting was ideal for his purposes.

September 5–7, 1986. The first opportunity for Kuban and me to obtain cores from the Taylor site came when we met with Gayle Golden at Glen Rose for part of her extensive interviews. She was writing a background story about the personalities associated with the Paluxy "mantrack" claims over the years, which eventually was published in late October (Golden, 1986b). Heavy rains once more brought the river roaring high on its banks, however, so coring was impossible. In between interviews and photography sessions, Kuban and I tried out our coring tool on a large piece of limestone taken well away from the river.

We also tested Morris's claim that limestone could be stained with hydrochloric acid and iron sulfate. On the same piece of rock, we found that rusty stains could indeed be produced. The color resembled that of some colorations at the Taylor site which had been surface-oxidized. This was especially true using just the iron sulfate solution. But there the resemblance ended. The true stains had a mere topical appearance, while the colorations actually associated with the tracks appeared to be a part of the substrate. The stains had runny, irregular edges, bearing no resemblance to the smooth contours outlining the dinosaurian colorations. And even days later, the stains could be easily rubbed off the surface of the rock specimen, whereas the colorations seem to change, if ever, only after months of river action and then sometimes to brighter colors.

But as Kuban and I spent the remainder of the weekend visiting the Thayer site or Dinosaur Flats in south Texas and high water continued to prevent us from doing any work in the Paluxy, we knew we would still have to get our own cores to clinch the case for genuine subsurface colorations and to see exactly what Morris had seen in his cores.

September 20–23, 1986. True to its steep gradient, the Paluxy subsided to a level not much higher than, and just as calm as, that of October 1985 when visibility was optimal, though the tracks were still submerged (Hastings, 1986). Jeremy Taylor and British biologist Richard Dawkins came to Glen Rose to film part of a documentary based upon Dawkins' new book, *The Blind Watchmaker*, an inquiry into the argument from design. The Paluxy "mantracks" were to be used as a vehicle demonstrating the pseudoscientific lengths to which people go to argue against naturalistic explanation. With the help of students Brian Sargent, George Cole, and Liz Shelley, Jeremy Taylor, Dawkins, Kuban, and I cleaned part of

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the Taylor site for filming. (Remnants of Baugh's sandbagging were still present.) Our own sandbagging proved unsuccessful, so a large aquarium was used to expose some of the Taylor site tracks. Al West voluntarily prepared the West site for filming. For two days a film crew from Dallas shot several scenes with Dawkins as narrator and Jeremy Taylor as director, employing Kuban and me in scenes at the Taylor site (accessed elsewhere than through the McFall property), at a sauropod trail in Dinosaur Valley State Park, at the West site, and at the old McFall site upriver from the Baugh-McFall site. The film is scheduled for its debut in the United Kingdom in 1987.

During this time, Kuban and I were able to take our cores. We first noticed that the creationists' cores now numbered about twenty and that, on some multicolored tracks (for example, Taylor track IIS–1 and Ryals track Ry+4), several of these large core diameters (one-and-one-half inches) seemed to deface the tracks. It was interesting to note that among the tracks Baugh had sandbagged the previous month was GR–1 of the Giant Run, a track Kuban and I discovered in 1984. With permission from the state park officials, we took a total of seven five-eighths-inch cores, most of which corresponded with some of Morris's, in order to see what he had seen, and all of which were located on a coloration boundary to catch any subsurface distinction between inside and outside the tracks.

Five of the seven were from "mantrack" trails (Taylor, Ryals, and Giant Run), while the other two were from a trail everyone called dinosaurian (IIDW). All showed quite clearly a distinct boundary between the grayish, claylike material inside and beneath the track area and the ivory-tan limestone outside the track area—just as Kuban and I had predicted since late 1984. No microscopic analysis was needed to confirm that the colorations were indeed subsurface phenomena, extending at least several centimeters below the surface, and that the oftimes reddish-rust color was the oxidation of the surface of the claylike "inside" material. The difference between the "inside" and "outside" material could be felt when holding the coring bit: the claylike material yielded to the bit much more easily than the limestone. Later, back in Ohio, Kuban observed that weak hydrochloric acid reacted differently inside and outside, as one would expect when comparing clay and limestone (Kuban, 1986c).

Questions remain about the exact geochemistry of the colorations and how they formed, though all of Kuban's and my observations are consistent with an infilling mechanism, in which the tracks were soon covered after they were made. These questions are being investigated in labs available to Jim Farlow, using our cores. No question remains, however, concerning Morris's "last ditch" hope for "mantrack" enthusiasts. The colorations, which even the ICR could not ignore, are genuine; fraud or hoax is out of the question—they are far from "inconclusive."

The ICR has declared that either the colorations show the tracks to have been dinosaurian all along or they are fraudulant. By their own logic, the cores Kuban and I took eliminate the latter possibility. However, the same cores raise such

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interesting questions as: did Morris see in his cores what we readily saw in ours? If not, why not? If so, does that explain his unwillingness to display his cores? Does Morris not see that, regardless of mechanism or geochemistry involved, the fraud hypothesis is utterly rejected? Based upon Morris's behavior in the summer of 1986, Kuban and I suspect that he did, it does, and he cannot or will not.

October 1986. Creationist John DeVilbiss, former critic of Baugh's work yet still a "mantrack" enthusiast, conducted work on a site just across the Paluxy from the old McFall site and noted several "possible mantracks." Though well documented and mapped, in contrast to the lack of such documentation in earlier creationist work, DeVilbiss identified erosionlike depressions on a well-eroded part of the riverbed as humanlike. Some of these are similar to erosion marks on the Park Ledge (Godfrey, 1985; Godfrey and Cole, 1986). Two of some seven or eight depressions could be correlated as being alongside highly eroded dinosaur trails, which is consistent with Kuban's and my hypothesis that many "mantracks" alongside dinosaur trails were made by the dinosaur's tail or other appendage (Hastings, 1986).

This creationist work was supported in part by contributions from Ohio creationists, and, according to the April 1987 *Acts & Facts*, DeVilbiss was assisted by Baugh. If indeed Baugh did assist in this work, it is indicative that creationists do not consider Baugh to be as much of a liability as when he directed earlier work. Previously that summer, when John Morris visited the Paluxy prior to the creationist conference, he had consented to Baugh's assistance with apparent reservations (Golden, 1986b).

December 1986. Baugh, assisted by Dr. Marlin Clark (Institute for Creation Research, 1987), resumed his excavation activities at a new sight just downstram from the old McFall site and upstream from the site of Baugh's excavations in 1982 and 1983 (Godfrey, 1985; Godfrey and Cole, 1986; Hastings, 1985, 1986). After a flourish of media coverage, Baugh's new "mantracks" kindled little or no interest, even from local Glen Rose residents.

January 31, 1987. Jim McDonald, Dan Hastings, and I visited Baugh's new site as well as DeVilbiss's site. In a relatively small excavated area, Baugh had exposed elongate depressions very similar to those he had called human in 1982. Of the five or six depressions, none correlated in any way to form a trail and none had features remotely resembling features of human tracks in soft mud. The area exposed was too small to correlate with dinosaur trails at this time, although these depressions were on the same level as the nearby old McFall site, which displayed several dinosaur trails.

Meanwhile, my article on Kuban's and my debunking of the "best" of the creationist "mantracks" at the Taylor site appeared in the *Journal of Geological*

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Education (Hastings, 1987).

February 1987. John Morris and David McQueen arrived on the scene of Baugh's new site to assess the finds and to try to learn more about the colorations at the Taylor site (Institute for Creation Research, 1987). Though described as "insufficient to convince a skeptic," the new depressions, according to the ICR, "do show evidence of human toe marks which seem to support a human interpretation." Thus is new hope among "mantrack" enthusiasts encouraged. Interestingly, Baugh's new work is described as "based on the higher standards of precision with which Dr. Baugh is conducting his excavations," as if even the ICR recognizes that his previous work left much to be desired. Results of the ICR's coloration study are promised at a later time.

March 22, 1987. Baugh's new site had been slightly enlarged by this date, revealing along one side of the excavated area an unmistakable dinosaur trail with which at least two of the "mantracks" could be correlated as tail or other appendage marks. Ironically, as more effort is made by the mantrackers to display "mantracks" alongside dinosaur tracks, the more those "mantracks" show themselves continually explicable by Kuban's and my dinosaur marking hypothesis.

March 28–29, 1987. On March 29, on one of the field trips associated with a Geological Society of America meeting in Waco, Texas, paleontologist Jim Farlow led a group, which included "Raider" Steven Schafersman, to see the dinosaur and "mantracks" at Glen Rose. The previous day, Kuban and I had met to prepare the Taylor site for observation by this field group. We also took a few more cores of the coloration phenomenon to further our previously published analyses (Hastings, 1986, 1987; Kuban, 1986a, 1986b). Unseasonably inclement weather, including snow on March 29, prevented the group from wading into the chilly water to see the colorations.

Kuban's and my later cores showed the coloration phenomenon to be deeper than previously thought. The coloration material inside the track area is more dolomitic in content and more claylike in consistency than the outside dolomitic limestone. Its tendency to surface oxidize upon exposure reflects a different geochemistry than that of the riverbed limestone. Consistent with these findings is a scenario in which terrigenous material mixed with lime mud precipitated from a mixture of fresh water and sea water at high tide, infilling fresh dinosaur tracks made on a lime mud tidal flat at low tide. Selective diagenesis, augmented by algae in the pools left in the almost completely infilled tracks, could also have played a role in forming the different geochemistry inside the tracks. Subsequent lithification and recent reexposure led to the tridactyl-shaped coloration phenomenon seen today, which constituted the most vivid evidence demonstrating the dinosaurian origins of all the Taylor site trails (Hastings, 1986, 1987; Kuban, 1986a, 1986b;

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Golden, 1986b; Lemonick, 1986; Wilford, 1986).

Kuban's forthcoming history of the Paluxy "mantrack" claims, "The Paluxy Mantrack Controversy," will detail events concerning "mantracks" so that in the future few questions about exactly what happened should remain. Kuban has recently located the original Osborn-Caldwell track and has plans to include in the history the evidence which shows this track to be a carving. Also to be included in his book will be details of how "sworn statements" of old-time Glen Rose residents were misrepresented by creationist mantrack enthusiasts.

April 1987. By this time, the entrance building of Dinosaur Valley State Park near Glen Rose featured a small museum-quality display for visitors. A painted mural of the dinosaurs thought to have made the Paluxy riverbed tracks covers one wall, while an updated depiction of dinosaurs in general and a pictorial geological history of the area are on other walls. It is good to see that some measures have been taken to fulfill Roland T. Bird's dream of the park becoming the scientific center of attraction it deservedly is, in addition to being a fine recreational area. In contrast, Baugh's Creation Evidences Museum, which is located nearby in a used trailer house, has become dormant despite piles of building material for future "phases" on site. This represents an almost total reversal in activity from that of 1982 to 1983 when Baugh was attracting considerable support and the park seemed destined for no foreseeable improvement (Hastings, 1985).

June 24, 1987. Baugh announced the discovery of a "human tooth" and a "trilobite" at a new site where he had been attempting to uncover mantracks since December 1986. ("Mantracks," announced in January 1987, were not mentioned.) On local television stations from Dallas-Forth Worth, Baugh was accompanied by a new set of "scientists" authenticating the finds. The tooth, heralding the presence of "Glen Rose Man," according to the finders, was pronounced that of a female (how that was ascertained was not explained) and given the age of six million years. This age is not only unrelated to the Cretaceous marl layer sandwiched between limestone slabs, the lower of which contains most of the dinosaur tracks and all of the alleged mantracks and in which the tooth was presumably found, it is completely incompatible with the young-Earth, flood-geology cosmology espoused by Baugh in the past. Identified as a bicuspid (premolar), the tooth appeared on video to have at least a couple of cusps but seemed too elongate to be human. Only the crown was present; the root system was completely missing. It was black in appearance, as if it had been carbonized similar to the dinosaur bones Baugh found in 1984 (Hastings, 1985). Baugh claimed it to be "completely fossilized," as if lithified like any Mesozoic fossil.

Presumably also similarly lithified, and definitely similar in coloration, was the "trilobite." What was shown was a string of black, bead-like segments bearing little resemblance to the common flattened trilobite fossil shells or to a "curled-

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up'' trilobite fossil shell. If indeed this specimen is a trilobite, it probably is the remnants of a molt. But trilobites did not survive into the Mesozoic, and this new claim resembled Baugh's earlier trilobite claim, which was shown to be a Silurian specimen in Niagaran limestone from Illinois lost or ''salted'' along the Paluxy River bed near Glen Rose (Hastings, 1986).

I had had ''early warning'' of these claims the previous Friday, June 19, when I visited the site and talked with one of Baugh's new coworkers before the reverend arrived upon the scene. Appearing as if under a lot of duress and possibly upset over the U.S. Supreme Court decision on the Louisiana creationism law announced just that morning, Baugh uncharacteristically lashed out at me, calling me an ''atheist, ''humanist,'' ''infidel,'' and ''liar,'' condemning me to hell one minute and wanting to ''win me to the Lord'' the next. He accused me of ''cramming evolution down the throats of children,'' an amazing feat considering I teach predominantly physics, calculus, and trigonometry. He would not tell me what his ''surprise'' was going to be the following Wednesday, but I, of course, already knew.

Early July 1987. In What must be seen as a pleasant surprise, Baugh took his ''human'' tooth to the Balcones Lab near Austin for identification. Rarely does Baugh behave so scientifically, so this action alone was to his credit. But his trip probably was indicative of his supreme confidence that he had a genuine human tooth from Cretaceous deposits, a piece of evidence that would at last ''topple evolution'' as his ''mantracks'' so miserably failed to do. Unfortunately for Baugh, once again, his evidence does not seem to merit such confidence.

Communication from paleontologist Wann Langston, Jr., states that the other fossilized teeth that Baugh brought in addition to the ''human'' tooth were clearly grinding teeth of pycnodonts, Mesozoic bony fish related to modern gars and bowfins. Worn-down incisors of pycnodonts, possessing a couple of cusps, would indeed have a superficial resemblance to human dentition in the eyes of the zealous and the uninformed; Baugh's ''human'' tooth is most likely such an incisor. Remains of pycnodonts have been found in the lower Cretaceous deposits of central Texas and, though long known, have not been widely studied. It is also known that Cretaceous precursors of the modern sheephead fish had broad incisors. Such remains in the Glen Rose limestone are compatible with the well-known lower Cretaceous ecology of a large, flat marine tidal basin upon which the dinosaurs trod at low tide. As ''Nebraska Man'' turned out to be a pig's tooth, it looks as if ''Glen Rose Man'' will turn out to be a fish's tooth.

Conclusion

Overall, the question of ''mantracks'' alongside those of dinosaurs along the Paluxy

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River in Texas has effectively been settled. Every phenomenon claimed a human footprint has been shown to be otherwise, including the "best" of the creationist mantracks at the Taylor site. As a scientific issue, the "mantracks" definitely "died" in 1984 with the measurements Kuban and I took on a dry Taylor site and with the discovery of the colorations (Godfrey, 1985; Hastings, 1986; Kuban, 1986a, 1986b). Anything "mantrack" enthusiasts did, short of unequivocally admitting the identity of the tracks, was "beating a dead horse." The exercise in damage control that Morris and the ICR have displayed since 1985 can only be seen as a desperate attempt to salvage some semblance of scientific respectability. To me, the attempt has been a dismal failure.

The insights into dinosaur locomotion and behavior which were brought about by the colorations have been, indeed, pleasant, unexpected surprises. The pursuit of "mantracks" leading to significant advances in dinosaur ichnology illustrates nicely the excitement in science borne by unanticipated discovery. But the Paluxy "mantracks" illustrate much more for both scientists and observers of creationism.

That the "mantracks" were an important cornerstone in modern creationism cannot be denied, despite recent creationist attempts to do so (H. Morris, 1986). That the ICR is still attempting to cling to this now missing cornerstone also appears evident, as shown by the Paluxy section at the ICR museum and an ICR logo (Cole, 1986). Analogies of the Paluxy "mantracks" with Piltdown man have already begun to appear in Christian publications (Price, Wiester, and Hearn, 1986), but some of the differences between the two cases are at least as important as the similarities.

Whether Piltdown is seen as an impish prank or as a diabolical act of entrapment borne of jealousy (Gould, 1980, 1983), it cannot be seen as a tool of an extrascientific movement as can the Paluxy "mantracks." Nor can it be seen in Piltdown a reluctance to openly "blow the whistle" on colleagues when scientific problems are discovered. Though it is true that early on fellow creationists disputed the "mantrack" claims of their colleagues (Kuban, 1986a, 1986b; Price, Wiester, and Hearn, 1986), such criticism was not carried through to a resolution of the disagreements, as in the case of scientific disputes. Even in cases of very questionable behavior on the part of creationist "mantrack" seekers (Hastings, 1985), creationists visiting the "mantrack" sites seemed reluctant to criticize publicly those of their own metaphysical beliefs. They only did so privately. Such nonscientific behavior might be attributable to loyalty to a nonscientific cause, usually religious or political, in which scientific problems are perpetuated or purposely overlooked for the "higher" good of the movement. When conversing with Richard Dawkins on this subject, he reminded me of J. B. S. Haldane's reluctance to criticize Lysenkoism in the Soviet Union due to his communist sympathies.

As one of the few cases of actual creationist field research, the Paluxy "mantrack" episode will serve as a paradigm case against creationism. Its impact should remind science that ignoring pseudoscience is often unwise, and its unraveling

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should remind everyone that, within science, scientific investigators, even with diverse backgrounds, philosophies, and perspectives, can and do agree (Golden, 1986b).

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Letters to the Editor

I am pleased that your correspondents Fezer and Greene (*Creation/Evolution* XX) were favorably impressed by my pro-evolution argument based on the observation of the same genetic "errors" shared between different species (*Creation/Evolution* XIX), and I am happy to address the "loose ends" they question.

1. The legal cases that I cited (in which shared errors were taken as evidence of plagiarism) are: *Colonial Book Co., Inc.* v. *Amsco School Publications, Inc.*, District Court, S.D. New York, September 9, 1941 (the chemistry textbook case), and *Sub-Contractors Register, Inc.* v. *McGovern's Contractors & Builders Manual, Inc.*, et al. District Court, S.D. New York, August 2, 1946 (the construction industry directory case). These and several other cases making essentially the same point are cited in *Nimmer on Copyright* by Melville B. Nimmer (1985, volume 3, pp. 13-44 to 13-45.

2. The quantitative comparisons between the two human epsilon pseudogenes and the functional human epsilon gene show 98 percent nucleotide identity for the truncated classical pseudogene and 86 percent identity for the processed pseudogene (comparing the corresponding coding sequences of each pseudogene with the functional gene). The probability of these sequence similarities occurring by chance is extremely small. Though I have not made a formal calculation of the odds, the statistical remoteness of such an event may be compared with an example often cited by the creationists: the likelihood of a hurricane blowing through a junkyard and assembling a 747 airliner. The reason that this picturesque analogy applies to the formation of the pseudogenes and *not* to the formation of *functional* genes is critical but is commonly overlooked by creationists. Their often heard argument—about the statistical improba-

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bility of assembling the one hundred amino acid sequence of a typical protein by a random selection of amino acids—simply suggests that such *single step* selection is not a reasonable model for the evolution of protein sequences, a conclusion that evolutionists can readily accept. Instead, functional genes evolved by *multiple successive mutations*, each one of which was *not* highly improbable, and each successive mutation was selected by its improved function compared with that of the predecessor gene or other competitors. As beautifully presented in Richard Dawkin's recent book, *The Blind Watchmaker*, this model can readily explain the evolution of functional genetic sequences of high complexity. In contrast, *functionless* genetic sequences are not subject to this mechanism because they are not subject to selective pressure. Thus, if one wants to discard the obvious explanation of pseudogenes—namely, that they derived from functional genes—and consider instead that their similarities to functional genes are due to chance coincidence, then the likelihood of the observed sequence similarities arising by chance can only be estimated by the sort of single-step model that the creationists convincingly argue is negligibly likely.

3. The sequence discrepancies between gene and pseudogene can be classified according to their position in the triplet-nucleotide codon as suggested by Fezer. For the record, the discrepancies for the case of the truncated classical epsilon pseudogene break down as follows: four in the first position of the codon; two in the second; and five in the third. A more sophisticated analysis would consider which mutations, regardless of their position in the codon, actually cause a change in the amino acid encoded (Perler et al., *Cell*, 1980, 20:555). Additional evidence to test the nonfunctional nature of pseudogenes will come when the sequences of the corresponding human and nonhuman pseudogenes are available for comparison. To the extent that the pseudogenes were nonfunctional throughout their history, the frequency of human versus nonhuman sequence discrepancies *within* the pseudogenes should equal the frequency of discrepancies in the *surrounding* nonfunctional DNA matrix.

4. It is true that most sequence comparisons between human, chimpanzee, and gorilla suggest that human-gorilla species divergence occurred before the human-chimpanzee divergence—a conclusion opposite to that suggested by the presence of the classical epsilon pseudogene in human and gorilla but not in chimpanzee. As Fezer suggests (and as was pointed out both in our original paper noting the absence of this sequence in chimpanzees and in the paper from Honjo's laboratory), the absence of this pseudogene in chimpanzees could be explained by a deletion of this sequence from the chimpanzee DNA. If such a deletion occurred, it should be demonstrable by a detailed comparison of the immunoglobulin gene locus of chimpanzee and human; such an analysis has not yet been reported. In the meantime, it is worth considering that cur-

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rent estimates of the dates of divergence of these three species are largely based on *quantitative* estimates of species differences. These estimates suggest that the gorilla-human and chimp-human splits occurred *closer to each other* in time than the interval between either of these and the present, so it is not surprising that a relatively small error in either divergence date could obscure the true sequence of events. For example, a small systematic increase in the rate of accepted point mutations in gorilla could have increased the human-gorilla differences and led to the present observed sequence comparisons that would thus overestimate the time since the human-gorilla split. As pointed out by Honjo's laboratory (Ueda et al., *PNAS*, 1985, 82:3712), the absence of the classical pseudogene in chimpanzees represents a *qualitative*, yes-or-no distinction between that species on one hand and human and gorilla on the other hand that may reflect the true sequence of species divergence unobscured by possible variations in the mutation acceptance rate. Additional evidence for the close human-gorilla relationship may be forthcoming if other qualitative discrepancies support the distinction between chimpanzees versus gorilla and human.

5. Finally, I would like to comment on a creationist response to the shared pseudogene argument that was communicated to me in private correspondence. How can we rule out the possibility that the sequences we call pseudogenes are not genetic errors but functional genetic elements designed by a creator for purposes that we do not presently understand? According to this view, the presence of the same pseudogene in different species could be explained by the usual creationist explanation for species similarities: that the creator designed similar species to function similarly on all levels, including the function—as yet unknown—of pseudogene sequences.

It should be stated that it is virtually impossible to prove with mathematical certainty that any biological structure is completely functionless. However, several facts we have learned about genetics in recent years strongly predict the existence of pseudogenes, at least of the "classical" type. Thus:

(*a*) It is clear that genetic sequences can be duplicated. Evidence for such duplication comes from genetic comparisons between individuals of the same species showing duplications in one individual that are absent in another. Such duplications even can be observed in comparisons between individual organisms from successive generations.

(*b*) Mutations are known to occur, altering the genetic information from one generation to the next, sometimes destroying the function of genes.

(*c*) It is known that, after genes are duplicated, mutations that destroy the function of one copy do not generally cause a serious problem for the organism because of the presence of the other functional

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copies.

(*d*) Finally, it is clear that there is no mechanism for the cell to recognize functionless genetic sequences and eliminate them from its DNA. Higher organisms do not appear to be under much selective pressure to minimize the amount of genetic information they carry.

These principles predict that functionless genetic sequences derived from duplicate gene copies—that is, pseudogenes—should occur at some frequency in higher organisms. Now we find genetic sequences that appear to fit exactly what these principles predict: crippled duplicates with no identifiable function. Clearly, it makes most sense to tentatively consider these pseudogenes to be examples of the functionless sequences expected from the genetic facts listed above.

The alternative—to consider these sequences serve a physiological role—seems to violate Occam's razor: we would have to postulate that unexpected novel functional elements have been discovered, elements whose function is unknown, unsupported by any experimental evidence, and would have to violate many principles we have learned from experimental study of normal functional genes. For examples like the epsilon classical pseudogene—shared by some but not by other very similar species—if we postulated an important function for this sequence in humans and gorillas, we would have to explain how chimpanzees survive without it. Finally, we would have to explain why we have not observed the functionless pseudogenes expected from the facts listed above. This view of pseudogenes is clearly opposed by common sense. Furthermore, it would seem even more preposterous to suppose that retroviral sequences embedded at the same position in the DNA of humans and apes represent functional sequences. The most reasonable conclusion is that these useless DNA segments represent the products of genetic accidents that occurred in a common ancestor of ape and humans and that, despite their uselessness, these sequences were copied into the DNA of the modern descendants of that ancestor (human and ape).

—Dr. Edward E. Max

After reading the article by Francis J. Arduini in *Creation/Evolution* XX, I felt compelled to write—not because the article was poorly done (in fact, it was quite well written) but because the target of the article was wrong. That is to say, from what I read I believe that the point which was made and the point which was supposed to be made are two different things.

As I understand the article, the object was to refute the "argument from design." However, I missed exactly how this was done. Without a doubt, the article demonstrated a potential weakness in the "if watch, then watchmaker" analogy, but this does not in any way weaken the true argument.

It seems that Mr. Arduini mistook an illustration of the argument for the argument itself. No argument ever

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relies upon the validity of its illustrations to prove its truth. If the analogy is inaccurate, then it might be best not to use it, but it does not reflect in any way upon the accuracy of the argument. . . .

The purpose of the "if watch, then watchmaker" analogy is not to define the argument from design but, instead, to show that it is not unnatural or illogical to assume a creator when confronted with nature. The analogy points out the fact that, whenever we are confronted with an organized product, the initial and natural reaction is to assume that an organizer exists. . . .

The analogy does not say that creation was made in the same way that the watch was made. The analogy says that if we find organization we should look for an organizer. The argument from design declares that reason should dictate the assumption of a creator when confronted with nature in the same way the existence of a watch causes reason to conclude the existence of a watchmaker.

. . . Mr. Arduini's article also misses the point by not really understanding the meaning of the word *design*. . . . To define design from the article would have one believe that the products of design would always be acceptable to the American commercial society. There is much more involved in design than what was presented. Rather than proving that there is no real design in nature, Mr. Arduini simply showed that he would not hire the creator of the universe as a design engineer. . . .

Based upon an understanding of design, the argument from design poses two questions: (1) can *random* events produce an *ordered* product, and (2) does the presence of an *ordered* product imply *design?* According to the argument, the answer to the first question is "no," and the answer to the second question is "yes." At this point, to conclude that a designer exists is nothing more than common sense. . . .

—*Russell Trojan*

I am a reasonably intelligent human being. Being interested in the creation-evolution debate and being a Christian, I sought as many books on both sides of the issue as I could. Mostly, I did not believe the creationist ideas, but I heard them out. I listened to their radio shows and subscribed to the ICR newsletter.

Soon, I found myself in an odd position. As I listened to their case, I had two feelings. On one hand, my stomach seemed to knot up because I sensed that I was hearing something that was essentially wrong, but I could not put my finger on why it was wrong. On the other hand, my uneducated (in science) layperson's view could not argue successfully against what seemed to be impressive facts presented by mature scientists. After a while, I found myself gradually saying, "I think this creationist stuff might—just might—have something to it."

I decided to trust my stomach.

Boy, talk about being vulnerable! If anybody ever asked me why I opposed creationism, my only answer

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would have been, "I don't know. My stomach gets upset when I hear about it." I would have been made into mincemeat by a committed creationist's intellectual attack. I had no real *scientific* arguments [to throw] back to him.

Then I discovered you guys and a whole lot of confidence came flooding back. You offer current, specific responses to the creationist arguments. I feel like I was "had" by those guys and their "evidence." I feel like a light has been lit inside me. Thank you. Thank you.

I have tried to keep my wits about me during all this searching of the creation-evolution issue. Those guys have radio, churches, subscriptions (for *free*!), and are networked with many other groups. (You guys are not very well known, it seems.) They state their case over and over and over. They almost won me—almost. I fought. I can understand how people who are sympathetic to their cause can become loyalists. Many folks don't appreciate and don't care about the ambiguities of mature faith and mature science. They genuinely want to clarify their faith with uncluttered "science" that has all the answers. Some really do push away their doubts about creationism because they've been warned that acceptance of evolution is being a traitor to God.

I am helping to spread your newsletter around the science department at my school, the library, and my friends.

—*Paul R. Blundin*

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Copies of the historic *amicus curiae* brief, filed in the U.S. Supreme Court appeal of the Louisiana "equal time" law on behalf of seventy-two Nobel laureates and various scientific organizations, can be ordered from the Southern California Skeptics. Hailed as one of the best and most thorough briefs in the case, it reviews the legal, educational, and scientific issues, authoritatively making a case against the "equal time" for creationism law. Price: $6.50 (includes shipping) from:

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